WHAT IS CLAIMED IS:

1. An exponential conversion circuit comprising:

a first voltage conversion circuit for converting first and second reference input voltages to first and second differential output voltages on the basis of a first gain control signal;

a first exponential conversion device for creating a first output current which changes exponentially with respect to the first differential output voltage;

a second exponential conversion device for creating a second output current which changes exponentially with respect to the second differential output voltage;

a current comparison circuit for changing the first gain control signal in accordance with a ratio of the first and the second output currents;

a second voltage conversion circuit for converting a control input voltage and the first reference input voltage into third and fourth differential output voltages, respectively, on the basis of a first gain control signal; and

a third conversion device for creating a third output current which changes exponentially with respect to the third and the fourth differential output voltages.

2. The exponential conversion circuit according to claim 1, wherein the first and second voltage

conversion circuits have a common-mode detection circuit and a common-mode feedback circuit, respectively.

3. The exponential conversion circuit according to claim 2, wherein the circuit comprises a logarithm conversion device so that a reference voltage is input to the common-mode feedback circuit, and that the reference voltage becomes a logarithm of the reference input current having a temperature characteristic.

4. The exponential conversion circuit according to claim 1, wherein the first and second conversion circuits comprise an electric field effect transistor operated in a weak inversion area respectively.

5. The exponential conversion circuit according to claim 1, the first and second exponential conversion circuit comprise bipolar transistors, respectively.

6. A variable gain circuit comprising:

an exponential conversion circuit according to claim 1; and

a plurality of variable gain amplifiers mutually connected in series wherein a gain is controlled with the third output current of an exponential conversion circuit according to claim 1.

7. An exponential conversion circuit comprising:

a first voltage conversion circuit for converting first and second reference voltages to first and second differential output voltages, respectively, on the

basis of a first gain control signal;

a first exponential conversion device for creating the first output current which changes exponentially with respect to the first differential output voltage;

a second exponential conversion device for creating a second output current which changes exponentially with respect to the second differential output voltage;

a current comparison circuit for changing the first gain control signal in accordance with the ratio of the first and second output currents;

a second voltage conversion circuit for converting a third reference input voltage and the first reference input voltage to the third and fourth output voltages, respectively, on the basis of the second gain control signal;

a third exponential conversion device for creating a third output current which changes exponentially with respect to the third differential output voltage;

a fourth exponential conversion device for creating a fourth output current which changes exponentially with respect to the fourth differential output voltage;

a second current comparison circuit for changing the second gain control signal in accordance with the ratio of the third and fourth output currents;

a third voltage conversion circuit for converting

the second reference input voltage and the third reference input voltage to fifth and sixth output voltages, respectively, on the basis of the third gain control signal;

a voltage comparison circuit for creating the third gain control signal in accordance with the ratio of the fifth or sixth differential output voltage as against the second gain control signal;

a fourth voltage conversion circuit for converting a control input voltage and the first reference input voltage to the seventh and eighth differential output voltages, respectively, on the basis of the third gain control signal;

a fifth voltage conversion circuit for converting the control input voltage and the first reference input voltage to a ninth differential output voltage on the basis of a fourth gain control signal; and

a fifth exponential conversion device for creating a fifth output current which changes exponentially with respect to the ninth differential output voltage;

wherein one of the seventh and eighth differential output voltages becomes the fourth gain control signal to change the fifth output current linearly and exponentially with respect to the control input voltage.

8. The exponential conversion circuit according to claim 7, wherein the first, second, third and fourth voltage conversion circuits have a common mode

detection circuit and a common mode feedback circuit, respectively.

9. The exponential conversion circuit according to claim 8, wherein the first gain control signal is input to the common mode feedback circuit in the third and fourth voltage conversion circuits.

10. The exponential conversion circuit according to claim 7, wherein the first, second, third, fourth and fifth exponential conversion devices comprise, respectively, electric field effect transistors which are operated in a weak inversion area.

11. The exponential conversion circuit according to claim 7, wherein the first, second, third, fourth, and fifth exponential conversion devices comprise, respectively, bipolar transistors.

12. A variable gain circuit comprising:

an exponential conversion circuit according claim 7; and

a plurality of variable gain amplifiers connected in series wherein a gain is controlled with the fifth output current of the exponential conversion circuit according to claim 7.

13. An exponential conversion comprising:

master exponential conversion circuits;

a polynomial circuit wherein output signals of the master exponential conversion circuits, reference input voltages and control input voltages are input so that

the control input voltage is converted in accordance with a predetermined function; and

a slave exponential conversion circuit to which an output voltage of the polynomial circuit is input;

wherein each of the master exponential conversion circuits comprises,

a first voltage conversion circuit for converting the reference input voltages to the first and second differential output voltages on the basis of the gain control signals;

a first exponential conversion device for creating a first output current which changes exponentially with respect to the first differential output voltage;

a second exponential conversion device for creating the second output current which changes exponentially with respect to the second differential output voltage; and

a current comparison circuit for changing the gain control signal in accordance with the ratio of the first and second output currents;

the slave exponential conversion circuit comprises,

a second voltage conversion circuit for converting one of the reference input voltages and the control input voltage to a third differential output voltage on the basis of the output voltage of the polynomial circuit; and

a third exponential conversion circuit for

creating a third output current which changes exponentially with respect to the third differential output voltage.

14. The exponential conversion circuit according to claim 13, wherein the first, second and third exponential conversion devices comprise electric field effect transistors which are operated in a weak inversion area.

15. The exponential conversion circuit according to claim 13, wherein the first, second and third exponential conversion devices comprise bipolar transistors.

16. A variable gain circuit characterized by comprising:

an exponential conversion circuit according to claim 13; and

a plurality of variable gain amplifiers (10,502,VGA 1st-nth) wherein a gain is controlled with the third output current of the exponential conversion circuit according to claim 13.

17. A variable gain circuit comprising:

an exponential conversion circuit according to claim 1;

a first electric field effect transistor wherein a gate and a drain are mutually connected, a source is connected to the ground point, and a second gain control signal of the exponential conversion circuit

according to claim 1 is given to the gate as a bias signal;

second and third exponential electric field effect transistors constituting a differential amplifier circuit, the second exponential electric field effect transistor outputting a first output signal on the basis of a first input signal, the third electric field effect transistor outputting a second output signal on the basis of the second input signal;

a first resistor device connected between the gate of the first electric field effect transistor and the gate of the second electric field effect transistor; and

a second resistor device connected between the gate of the first electric field effect transistor and the gate of the third electric field effect transistor;

wherein the first electric field effect transistor is operated in a strong inversion area, and the gain is controlled with the second gain control signal.

18. A variable gain circuit comprising:

an exponential conversion circuit according to claim 1;

a first electric field effect transistor wherein a gate and a drain are mutually connected, a source is connected to the ground point, and a second gain control signal of the exponential conversion circuit according to claim 1 is given to the gate as a bias

signal;

second and third exponential electric field effect transistors constituting a differential amplifier circuit, the second exponential electric field effect transistor outputting a first output signal on the basis of a first input signal, the third electric field effect transistor outputting a second output signal on the basis of the second input signal;

a first resistor device connected between the gate of the first electric field effect transistor and the gate of the second electric field effect transistor; and

a second resistor device connected between the gate of the first electric field effect transistor and the gate of the third electric field effect transistor;

wherein the first electric field effect transistor is operated in a weak inversion area, and the gain is controlled with the second gain control signal.

19. A variable gain circuit system comprising:

a variable gain circuit mutually connected in series according to claim 17; and

a variable gain circuit according to claim 18.

20. A variable gain circuit comprising:

an exponential conversion circuit according to claim 1;

a first electric field effect transistor wherein a gate and a drain are mutually connected, a source is

connected to the ground point, and a second gain control of the exponential conversion circuit according to claim 1 is given to the gate as a bias signal;

second and third electric field effect transistors constituting a differential amplifier circuit, the second electric field effect transistor outputting a first output signal on the basis of a first input signal, the third electric field effect transistor outputting a second output signal on the basis of a second input signal;

a first resistor device connected between the gate of the first electric field effect transistor and the gate of the second electric field effect transistor; and

a second resistor device connected between the gate of the first electric field effect transistor and the gate of the third electric field effect transistor.

21. A variable gain circuit comprising:

an exponential conversion circuit according to claim 1;

a first electric field effect transistor wherein a gate and a drain are mutually connected, a source is connected to a ground point, a second gain control signal of the exponential conversion circuit according to claim 1 is given to the gate as a bias signal;

a second electric field effect transistor for outputting an output signal on the basis of an input

signal; and

a resistor device connected between the gate of the first electric field effect transistor and the gate of the second electric field effect transistor.